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LANDSCAPE ASSESSMENT TOOLS FOR WATERSHED CHARACTERIZATION

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LTG 3 Poster 03

Science Questions

MYP Science Question:

- What additions to models are most needed for the TMDL process?

Research Questions:

- How can remotely-sensed data be used to derive information relevant to models?
- How can limited monitoring data be used to assess conditions regionally?
- How can recovery potential be defined and evaluated at the landscape scale?

Research Objectives

General Objective

- Develop a combination of compatible models and methodologies that can be employed and integrated at regional scales to provide practical means of guiding each phase of the TMDL process

Process Modeling

- Develop a GIS interface for automated hydrologic model parameterization
- Evaluate model performance and uncertainty
- Improve automated parameter estimation methods

Empirical Modeling

- Develop a means of tracking sediment movement at the landscape scale that accounts for soil type, climate, land cover/use, management, and topography

Statistical Modeling

- Develop practical means of identifying impaired waters and sources of impairment over large geographic areas
- Identify factors influencing recovery potential of impaired waters (indicators)
- Combine indicators in an assessment and priority-setting demonstration project

Supporting Tools

- Develop user friendly tools to perform complex spatial analyses in support of modeling and assessment efforts

Research Methods & Collaboration

Methods

Process Modeling

- Utilize national datasets to extract information for model parameterization
- Design tools to facilitate the practical use of complex process models

Empirical Modeling

- Compute erosion and sedimentation metrics using innovative GIS-based implementation of the Revised Universal Soil Loss Equation (RUSLE) and Spatially Explicit Sediment Delivery Model (SEDMOD)

Statistical Modeling

- Indirect measurements of known water quality (WQ) indicators
 - Utilize a combination of remotely-sensed data to develop and evaluate techniques for estimating impervious surface cover
- Landscape modeling of WQ impairment
 - Correlate landscape metrics with observed WQ impairment to establish a means of predicting impairment when observations are not available
 - Evaluate sampling strategies needed to support the development of regional models for WQ constituents
- Assessing Recovery Potential
 - Using established metrics of WQ impairment and biological integrity, establish scientifically defensible means of identifying waters with the greatest recovery potential

Collaboration

Process Modeling

- Co-development with USDA-ARS and the Universities of AZ and WY.
- Collaboration with EPA Regions 9 and 10 and the EPA Office of Water

Empirical Modeling

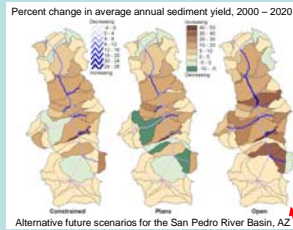
- Collaboration with statistical modeling group and the OW EMAP program

Statistical Modeling

- Maryland county, State of Illinois
- EPA Regions 3, 4, & 5
- USGS NAWQA program
- Office of Water
- NERL/ESD, EERD, ERD; NHEERL

Process Modeling

- Developed the Automated Geospatial Watershed Assessment (AGWA) tool for GIS-based hydrologic modeling
 - Integrated into Office of Water's BASINS 3.1
 - ArcView 3.X (available), ArcGIS 9.X (2006), and Internet (2006) versions
- Enables multi-scale assessments using basin- and watershed-scale models
 - Individual or multiple watershed assessment
- Enables visualization of distributed model outputs for both upland and channel areas
- Permits visual and numerical comparisons between simulations for forecasting and planning applications
- Alternative futures scenario-building tool



Statistical Modeling

Indirect measurements of known WQ indicators

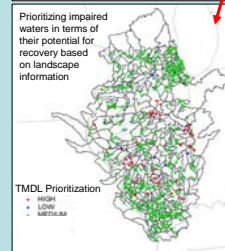
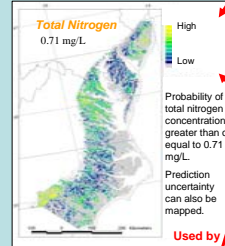
- Established relationship between impervious surfaces and population density, commercial/industrial land use, and roads
- Developed future projections for EPA Region 4
- Conducted ground truth accuracy assessments of estimation methods at multiple scales
- Initiated paired watershed study to investigate the impacts of different patterns of urban development (storm water management) on impervious surface estimation, stream flows, and channel morphology

Landscape modeling of WQ impairment

- Initiated Landscape Indicators for Pesticide Studies (LIPS)
- Developed probability-based sampling program
- Developed and applied landscape indicator statistical models for pesticides, nutrients, sediment, toxic chemicals, benthic communities, and physical habitat
- Validated models to produce accuracy estimates
- More cost-effective approach to identifying the condition of streams over large areas
- Helps state and local managers to target monitoring and prioritize remediation

Assessing recovery potential

- Initiated demonstration project for state of Illinois
- Identified physical and socio-economic indicators of recovery potential
- Developed simple logic models to identify where specific restoration activities may have the greatest effect
- Utilized cluster analysis to identify watershed characteristics associated with different impairments
- Established research partnership with University of IL to evaluate the potential for mapping tile-drained soils regionally
- Dataset still under development



Research Results

Empirical Modeling

- Developed an automated GIS watershed analysis tool for RUSLE/SEDMOD soil erosion and sedimentation modeling
 - Innovative GIS-based custom scripts
- Utilizes national datasets
 - STATSGO, NLCD, NED
- Computes grid-based estimates of gross soil erosion and sediment delivery rates
- Outputs employed by landscape models in combination with ATILA spatial analyses to support regional WQ assessments through statistical modeling

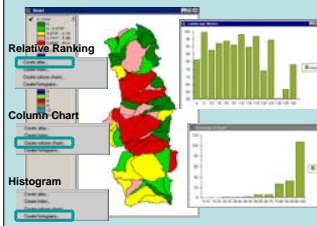
RUSLE Erosion :
Gross Soil Erosion Rate

SEDMOD Sedimentation :
Net Sediment Delivery Rate



ATILA Support Tool

- Developed the Analytical Tools Interface for Landscape Assessment (ATILA)
- Calculates most common landscape/watershed metrics with emphasis on water quality influences
- Requires minimal pre-processing of input data
- Scale independent
- Flexible, fast, repeatable, expandable
- ArcView 3.X (available) and ArcGIS 9.X (under development) versions



Interactions with Customers

Office of Water (OW)

- Incorporation of research products into OW tools (e.g. BASINS/AGWA) and coordination of ongoing development
- Customization of tools to accommodate OW needs
- Periodic workshops to improve alignment of OW needs, ORD research, and collaboration
- Direct collaboration and consultation on internal and external WQ research

EPA Regions

- Support for regional/state assessments (e.g. LIPS)
- Customization of tools to assist with regulatory activities
- Direct collaboration on demonstration projects for tech transfer

Other

- Collaborative research, development, & data collection
- Training

How Research Contributes to Outcomes

Basic research has been published in peer-reviewed journals, presented at scientific meetings, and integrated to provide management frameworks, guidelines, and modeling tools for our clients. Research products provide State and local WQ managers with tools to more effectively locate and identify sources of impairment, and to prioritize areas with the greatest potential for recovery. As a result, water quality goals should be more effectively met in terms of both cost and success.

Research Conclusions & Future Directions

Process Modeling

- Established a simple, defensible modeling framework
- Improve practical usability by incorporating new data sources, analytical tools, and models

Empirical Modeling

- Grid-based estimates of erosion/sedimentation can be developed
- Establish temporal relationship to stream flow
- Improve accuracy by incorporating new data sources

Statistical Modeling

- Indirect measurements of known WQ indicators
 - Developed and validated impervious surface models
 - Establish temporal relationship to stream flow
- Landscape modeling of WQ impairment
 - Impairment can be accurately mapped regionally based on a limited sampling program
 - Improve practical usability of technique through software development and documentation
- Assessing recovery potential
 - Recovery potential is a critical component of TMDL planning in need of scientific footing
 - Establish toolkit to guide states in TMDL prioritization
 - Track rehabilitation/recovery to validate models

Our research is focused on identifying and improving methods to utilize available data at landscape through regional scales to help states rapidly and inexpensively target and prioritize local-scale assessment, monitoring, and restoration activities. A variety of modeling approaches is employed to accommodate a wide range of specific objectives and data availability. Our research and development goal is to produce a collection of compatible tools and methodologies to support Clean Water Act (CWA) actions such as impaired waters monitoring and listing, TMDLs, and restoration priority setting. Products are designed to be used in concert to characterize watersheds at landscape or statewide scales and thereby improve CWA program implementation by making it more efficient and effective.

This poster presents a combination of completed and ongoing research that is aimed at improving the accuracy of regional assessments and the practicality of employing them in CWA programs. Interagency, inter-governmental, academic, and private partnerships are sought and exploited as a means to guide research and development and validate products through demonstration studies in various geographies.